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EDITORIAL

Though not recognized as an independent specialty by international, regional, or national pediatric/adult neurosurgical organizations, Neuroendoscopy Research is de facto recognized as a specific field of research by neurosurgeons, by all other medical and surgical specialties, and by society. The principles of neuroendoscopy surgery are being established, its limits extended and defined, and its practitioners identified. However, even after one hundred years of Neuroendoscopy Research, the various specific indications, pathophysiology in the treatment goal, treatment modalities and outcomes, and fundamental basic science, remain controversial. A journal specific to Neuroendoscopy Research is needed.

I chose to undertake this work together with an editorial board including major neuroendoscopy researchers worldwide. The very different national origins and ultimate life goals of the board members form the basis for the truly humanistic group of Neuroendoscopy Research.

Still, when all is said and done, how does a journal that hopes to be a humanistic treatment of a scientific discipline, one composed of theoretical and technical elements, come into existence? We are beginning this work with an exhaustive review of the literature over the past century, creating a Neuroendoscopy Research World Record Ranking [NERWRR] as a means of critically analyzing various diagnostic, and therapeutic aspects of neuroendoscopy in the history of Neuroendoscopy Research. In the critical review of nearly 1,000 publications in the NERWRR by the “Masters’ Publications” Review Committee, it was obvious that the Neuroendoscopy technology has been the source to advance the Neuroendoscopy Research. The collaboration with the International Federation of Neuroendoscopy [IFNE] and other international/continental/regional/national societies for neuroendoscopy is essential.

It is hoped that this “Journal of Neuroendoscopy” may serve as an ongoing update on Neuroendoscopy Research, while simultaneously stimulating present and future Neuroendoscopy Researchers to advance the present knowledge and treatment modalities in this field, less invasively and more completely to heal the sick patients.

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Frameless Free-hand Neuroendoscopic Surgery — Development of the Finest Rigid-rod Neuroendoscope Model to Cope with the Current Limitations of Neuroendoscopic Surgery —

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Summary

The author describes a new and advanced neuroendoscopic surgical technique, “frameless free-hand neuroendoscopic surgery” using a new neuroendoscope that offers improved access to intracranial lesions and maneuverability for various microinstruments during high-resolution imaging. The neuroendoscope has a rigid rod that is 2 mm in diameter and 16.5 cm in length, which is placed in the lower two thirds of an ovoid cannula that is 4.0 × 2.5 mm in diameter. The “gun-butt” holder which the operator grips with his/her left hand, provides stability to the holder and allows the endoscope to be handled with improved control. The surgical route is protected by insertion of a No. 12 or 14 French peel-away sheath. Various microinstruments can be introduced to the operative field via the upper one third of the cannula. These microinstruments are nearly as long as the body of the endoscope, and because these instruments are grasped directly by the surgeon’s right hand, fine neuroendoscopic surgical maneuvering is more readily achieved. The main technical advantage of the free-hand maneuvering of the Handy Small-diameter Rigid-Rod Neuroendoscope is that it can be held comfortably with one hand and instruments can be maneuvered in and out of the filed with the other. The author’s new neuroendoscopic technique, with Endoscope-stylet Technique for a peel-away sheath placement made it possible to deal with intravenousicular lesions even in the slit like centricles. It can be concluded that the new and advanced neuroendoscopic surgical technique with “Oi Handi Pro™” has expanded the current concept of the indications for neuroendoscopic surgery.

Key Words: neuroendoscopic surgery; free-hand technique; endoscope-stylet technique; slit-like ventricle
I. Introduction and Background

Intracranial endoscopic surgery (neuroendoscopic surgery) has progressed remarkably over the last two decades, and various intracranial pathological / pathophysiological conditions are now considered to be treatable with this developing “minimally invasive” neurosurgical procedure [9][10][11][12][13][14][15][16][17][18][19][20][21][22][23]. The endoscope apparatus used by L’Espinasse [3] played an important part in these first attempts at the treatment of hydrocephalus in 1910. Dandy in 1918 [4], and Putnam in 1934 [16], reported their experiences, which were mainly in endoscopic choroid plexus cauterization. Neuroendoscopic third ventriculostomy was then performed by various neurosurgeons, but it never became a standard technique, largely because the shunt procedure became a generally accepted method for the treatment for hydrocephalus. Although the placement of a shunt became a major therapeutic procedure with the development of silicone in the 1950s [8] and the condition of the majority of hydrocephalus patients was improved with this procedure, the management of hydrocephalus with shunts, regardless of design, is associated with a high incidence of complications. Neuroendoscopic third ventriculostomy (ETV) practices as an alternative to shunting procedures has revolutionized the management of hydrocephalus. Today, ETV is the procedure of choice for patients with non-communicating type of hydrocephalus caused by aqueductal stenosis and other types of ventricular cerebrospinal fluid (CSF) block, with the success rate reaching 60 to 85% in most reported series [1][2][5][6][7].

With the progress of instrumentations for neuroendoscope, the surgical applications of this neuroendoscopic system expanded not only to lesions related with the CSF circulation but also to management of intracranial tumors and others. The neuroendoscopic system has also come to be applied in micro-neurosurgical procedures, especially skull base surgery, intraventricular surgery and surgery for deep-seated tumors [10]. In dealing with these various pathological / pathophysiological lesions, it became clear that neuroendoscopic surgery requires some categorical differences in procedure corresponding to the nature of each lesion. Moreover, various types of endoscopy for neuroendoscopic surgery are now available, as well as the associated microinstruments. In addition to the flexible / steerable (fiber) type of neuroendoscope, which became less popular because of the limited sterilization method not able to prevent the possibility of prion disease by autoclave, there have emerged rigid-rod and semi-rigid-rod endoscope as alternative choices.

The author introduces the concepts and design of the “Handy Rigid-rod Neuroendoscope” (Oi Handy Pro™, Karl Storz, Tuttingen, Germany) with the clinical application for “Frameless Free-Hand Maneuvering”, and discuss the usefulness of this newly developed neuroendoscope and a new concept for neuroendoscopic surgical procedures, consequently to cope with the current limitations of neuroendoscopic surgery.

II. Indicated Diseases for Neuroendoscopic Surgery (Table 1)

The operative procedures achieved with this configuration included third ventriculostomies for non-communicating hydrocephalus, fenestration of septation of the hydrocephalic ventricle or septum in isolated ventricles (isolated unilateral ventricle), fenestration of arachnoid cysts and tumors, placement of ventricular tubes in ventricles or intratumoral cystic cavities, biopsies of intraventricular tumors and other advanced techniques. The history of neuroendoscopic surgery is essentially linked to developments in instrumentation. The first attempts at intracranial endoscopic surgery were performed using cystoscopes early in last century. Since then, the rigid type of endoscope had been the main instrument in this field, though many type of flexible viewing devices have been developed, for example those used in the upper and lower gastrointestinal system and upper respiratory tract. The quality of lighting guides and objective lenses has improved and micro-instrumentation has further developed for this rigid type of neuroendoscope. Through the straight working channel this system can accommodate relatively complicated instruments.

Operative procedures applied in neuroendoscopic surgery vary in their tissue disruption processes, which include vaporization, coagulation and mechanical manipulation. The former two maneuvers can be achieved by lasers (KTP and YAG fiberoptic lasers), monopolar/ bipolar coagulators, and other devices. Mechanical manipulation can be handle first by the microforceps, which can be passed through the working channel(s), thus facing a certain limitation in the variety and the function of instruments if a flexible endoscope is used. Ventriculostomy for non-communicating and choroids plexus coagulation for communicating hydrocephalus are still debatable on the critical point of whether the postoperative hydrocephalic condition is completely arrested or not. Since there is no definite investigation method by which to estimate preoperatively the postoperative CSF circulation and dynamics with satisfactory alternative CSF pathways and intracranial
pressure dynamics, this problem must be studied as one of the future topics of hydrocephalus research.

The major concern regarding choroid plexus coagulation is the human brain requires certain amount of CSF to keep the CSF circulation, essential to maintain homeostasis of the human brain metabolism. The condition of high protein with “waste chemical” of the brain metabolism in the CFS after choroid plexus coagulation is definitely non-physiological and harmful to the brain function. The essential therapeutic goal exists in the condition of arrested hydrocephalus with the CSF circulation maintained physiologically.

Shunt manipulation using the semi-rigid-rod endoscope will become more widely recognized as the benefits become more evident. There is room for improvement of the instruments for that purpose. Tissue biopsy and resection are another possibility for this type of neuroendoscopic surgery. Biopsy in the intraventricular location may be performed less invasively: this may require various forms of instruments, depending on the characteristics and location of the lesion. However, removal of deep-seated intraparenchymal lesions by purely endoscopic maneuvers is debatable. The procedures reported to approach such lesions are just “endoscope-assisted” micro-neurosurgery: the endoscope was merely used for better illuminations and visualization of the operative field in the “open” cannula. “Endoscopic surgery” must be defined as a procedure done in a closed cavity. The future aspects to be developed may, hopefully, include this concept as “micro-endoscopic surgery”.

### III. Neuroendoscopy: Fiber Endoscope vs. Rigid-rod Endoscope

1. The past

   The instrumentation in neuroendoscopic surgery has rapidly improved along with the most recent developments
The selection of each component should be based on the specific indication / clinical use of the procedures. The selection should consider the following factors: (1) high image resolution vs. mobility, for the neuroendoscope; (2) brighter operative field by specific system vs. adaptation of the available light source, for the lighting system; (3) a small but fine image for the video viewing system; (4) anticipated surgical procedures such as fenestration, resection, cutting, and coagulation, for microinstruments; and (5) for the assisting / supporting system, how much the surgeon extends the indication, with considerable understanding for the limitations of neuroendoscopic surgery.

There are various aspects that should influence the choice of neuroendoscope for clinical use. The most salient advantage of the rigid-rod neuroendoscope is its high image quality, leading the fine morphological analysis with much brighter illumination than its counterparts in comparison with the large size of lens in fiber or video scope. On the other hand, the most important advantage of the steerable-flexible neuroendoscope is its mobility in the ventricle or any other confined space, such as the cystic cavity of the brain parenchyma. The advantages of the semi-rigid-rod neuroendoscope include its fine structure, offering angulations in operative maneuvers, and its possible application as a stylet for shunt placement. The limitation of each type of neuroendoscope must also be understood. The fixed operative field and larger instrument size for the rigid-rod, and the dimmer operative field and limited choice of instrument size for the semi-rigid-rod and flexible / steerable-rod types, and considerable disadvantages. These advantages and disadvantages should be taken into account in the planning of individual procedures.

2. Towards conquering the individual disadvantages

We have been involved in development of a flexible-steerable neuroendoscope and advancements in instrumentation and surgical techniques [9][10][11][14] in the last decade of last century. CNS diseases and pathophysiology as neuroendoscopic surgical targets for these techniques include specific forms of hydrocephalus [13][15], deep-seated tumors, such as pineal region tumors [12], and others [10]. Recent advances in neuroendoscopic instrumentation have provided various types of neuroendoscopy in three major forms described as above. Significant advantages and disadvantages exist for each type. In addition to those technical standpoints of view, the critical disadvantage for fiber scope or video scope have been pointed out in the sterilization method. The fiber scope or video scope cannot be tolerated to the heat of auto clave to prevent prion disease, such as Creutzfeldt-Jacob disease. The mainstream of the neuroendoscopy clinically applied has been created with rigid-rod endoscopy in majority of countries in the world.

Following clinical experience using the various types of neuroendoscope, in 1997 we started to design and develop a new type of neuroendoscope combining the individual advantage of the three types, as a cooperative research project with Karl Storz (Tuttlingen, Germany). A prototype was finalized after several revisions of the model in 2003.

IV. Development of A New Neuroendoscope Model


Description of the “Handy Small Diameter Rigid-rod Neuroendoscope with three Working Channels” (Oi Handy ProTM, Karl Storz, Tuttlingen, Germany)

The body of the endoscope comprises an oval-shaped outer sheath (3.5 × 2.5 mm maximum diameter and 16.5 mm long), a rigid-rod objective lens (2.0 mm diameter with a 0°or 12°angle), a working channel (upper 1/3 of the sheath connected to 3 outlet/inlet orifices), and a handle attachment knob to which a holding handle can...
be affixed (Fig. 1). A fixation notch is also present, to which a holder-arm can be applied if the operator wishes to use the system under fixation rather than freehanded, although we have never required fixation procedures in neuroendoscopic surgery. The three-outlet/inlet orifices are used for irrigation (left), suction (center) and micro-instrumentation (right). Irrigation and suction procedures are undertaken by opening either the left or center orifice, respectively. The total weight of the neuroendoscope is 550 g with the endoscope connected to a lighting cable and camera. A number of microinstruments of 1.3-mm diameter are available, including micro-scissors, biopsy forceps, grasping forceps, mono-polar coagulator/cutting rod and bipolar coagulator. These can be introduced through the upper 1/3 of the neuroendoscope lumen.

V. Frameless Free-hand Technique Model

Through a burl hole, 8 mm in diameter, a 14 French peel-away sheath ("Oi Clear Navi Sheath") [19] is passed into the target ventricle. The endoscope is then inserted into the ventricle through the peel-away catheter, and anatomical landmarks are indentified. Steady holding of the endoscope in the surgeon’s left hand over the handle grip at the base allows quick back and forth movements along the long axis through in a peel-away sheath inserted to the ventricle and with minimally-required side shift of the tip of endoscope to the objective target. Using the right-most inlet/outlet orifice, the short and handy semi-flexible micro-instruments can be guided and controlled by the surgeon’s right hand (Fig. 2 B-D). Irrigation is facilitated by the assistant manually injecting artificial cerebrospinal fluid (CFS). For balloon techniques, a 2 French Forgatti micro-balloon (1.0 mm diameter and 5 mm maximum inflation) can also be manipulated right-handed at the right orifice (Fig. 2 A-H), placing the balloon at the best site for ventriculostomy. Inflation and deflation procedures are controlled by the assistant using manual manipulation of air injection with a 1-ml micro-syringe.

**Specific techniques for individual neuroendoscopic procedures**

*Third ventriculostomy:* Landmarks to guide the endoscope tip to the floor of the third ventricle have been described elsewhere[5][9]. The “Handy Small Diameter Rigid-rod

![FIG. 2: Frameless Free-hand Technique of “Oi Handy Pro™”](image)

**FIG. 2 A:** Steady holding of the endoscope in the surgeon’s left hand.

**FIG. 2 B/C:** Insertion of the endoscope with both hands’ holding through the peel-away sheath placed.
Neuroendoscopy” allows passage through a normal-seized foramen of Monro and a wide-angled operative field to discern intraventricular morphology (such as aqueductal stenosis, thinning of the third ventricle floor, etc.) with minimal axial movement of the endoscope sheath (Fig. 2E&F). A small hole is made for the initial opening at the center of the floor of the third ventricle, and can then be enlarged by micro-balloon inflation (2 French, 60 cm and inflated balloon diameter 5 mm). The tip of the “Handy Rigid-rod Neuroendoscope” is then passed through the ventriculostomized window to confirm opening of the Lilliquest membrane and morphology in the prepontine cistern.

Tissue biopsy: By inserting the “Handy Small Diameter Rigid-rod Neuroendoscope” through the peel-away sheath towards the lesion in the dilated or normal-sized or even slit-like ventricle (Fig. 3A), the neuroendoscopy trajectory is reserved with “Endoscope-style Technique” for a peel-away sheath placement (Fig. 3B&C). Once the tissue is detached from the body of tumor, the entire endoscope is removed through the guide sheath together with the micro-forceps grasping the tissue. The microforceps and accompanying tissue should not be removed though the
**FIG. 3 A-1&2:** A case of III ventricular tumor without hydrocephalus. Note the size of lateral ventricle remaining slit-like.

**FIG. 3 B-1 & 2 & 3:** A “Endoscope-stylet Technique” for a peel-away sheath placement into the slit-like ventricle using a 2mm-diameter lens of “Oi Handy Pro™” as a stylet under endoscopic vision.
working channel of the endoscope, as the tissue may be
damaged or tip of the microforceps may become caught
at the orifice of the endoscope (Fig. 3C&D). It is easy
for the surgeon to move the endoscope in this fashion
because of the free-handly maneuver.

**Fenestration of cyst wall:** In cases such as cystic
crianiopharyngioma, the cyst wall is fenestrated and
Ommaya tube placement is endoscopically assisted
through the foramen of Monro. This technique using the
“Handy Small Diameter Rigid-rod Neuroendoscope”
has been described elsewhere. The wall is soft enough
to be penetrated by the micro-forceps, and cystic
contents are sucked out using the suction function of
the neuroendoscope. The Ommaya tube, inserted via a
different burr hole, is grasped within the ventricle and
guided to the site of penetration of the tumor in the third
ventricle under the neuroendoscopic control.

**Shunt tube placement:** In order to place the ventricular
tube for ventriculo-peritoneal (V-P) shunt, the lens of the
“Handy Small Diameter Rigid-rod Neuroendoscope” is
used. After the ventricle is punctured using a manometric
ventricular trocar, the inner stylet with CSF pathway is
removed and data regarding intraventricular pressure
is obtained. The fine small diameter lens is inserted
through the outer sheath of the trocar, and intraventricular
morphology is confirmed to determine the best position
for placement of the ventricular tube. The outer sheath
allows the ventricular tube to be guided into position
through the sheath.

**VI. Conclusion**

In 1991, our newly developed flexible and steerable
fiberoptic operative viewing endoscope for the intracranial
use was reported and the system was described (The
first Symposium on Treatment for Handrocephalus, July
1991, the paper was published in 1992 [9]). The system
has been designed to be steered within the angles of +90
to -130 degree with a miniature high-resolution camera,
processor and monitor. This flexible viewing fiber has also
a working channel (diameter 1 mm) with a lighting guide
and objective lens. Through the channel, the system can
provide gentle irrigation in the ventricles with irrigation
or passage of microinstruments.

However, the clinical application to the various intra-
cranial lesions has faced to limitations with disadvantages

![FIG. 3 C-1&2&3&4: Toward the III ventricle with the choroid plexus as the land mark in the slit-like lateral ventricle.](image-url)
of the flexible-steerable (fiber) neuroendoscope, i.e. possibility of prion disease, poor quality of imaging compared by size, disorientation, limited instrumentations etc. To conquer these limitations of fiber endoscope, the authors have developed a new type of neuroendoscope, offering improved access to intracranial lesions and maneuverability for various micro-instruments under high-resolution imaging during neuroendoscopic surgery. The endoscope used in this model is a rigid-rod of 2.0 mm diameter with an ovoid cannula of 4.0 mm diameter. The “gun-butt” holder incorporated to the neuroendoscope for use with operator’s left hand provides stability to the holder and allows the endoscope to be handled with improved control. The surgical route is protected by insertion of a 14 French peel-away sheath. Various micro-instruments can be introduced to the operative field through the upper 1/3 of the cannula. These micro-instruments are almost as long as the body of the endoscope, so that direct handling by the right hand of the surgeon allows fine neuroendoscopic surgical maneuvering to be much more readily achieved. The main technical advance with this “Free-hand Maneuver” of the “Handy Small Diameter Rigid-rod Neuroendoscope is one’s ability to hold the endoscope comfortably with one hand and maneuver instruments in and out the field with the other. The results of early clinical experiences, with 0% mortality and morbidity, indicate the utility of these new concepts in both neuroendoscope and neuroendoscopic surgery. [J. Neurosurg (Pediatrics 1) 120: 113–118, 2005].

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References


FIG. 4: The histological findings of the biopsied tissue: germ cell tumor.
18. Oi, S; Samii, A; Samii, M: Frameless free-hand maneuvering of a small-diameter rigid-rod neuroendoscope with a working channel used during high-resolution imaging. Technical note. J. Neurosurg 102 (1 suppl): 113–118, 2005
Controversy in Neuroendoscopic Third Ventriculostomy: a Current Status Review

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Abbreviations: ETV, endoscopic third ventriculostomy; VP shunt, ventriculo peritoneal shunt; GCS, Glasgow Coma Scale.

Summary

Over 85 years have passed since the first clinical trials of endoscopic ventriculostomy for hydrocephalic patients. Indications for endoscopic third ventriculostomy (ETV) have been expanded to the treatment of not only obstructive hydrocephalus, but also some types of communicating hydrocephalus. While successful results have clearly been obtained for non-communicating hydrocephalus in recent clinical research, the pathological states which for ETV is effective remain enigmatic. ETV has also developed with advances in equipment and techniques. Following the evolution of ETV, complications have also changed and reduced in number. Many authors have reported age limitations for ETV in pediatric populations. This review therefore examined the literature on pathological indications for ETV, age limitations to ETV and complications to date.

Key Words: endoscopic third ventriculostomy; hydrocephalus; pediatric

Introduction

Many reports have examined the effectiveness and indications of third ventriculostomy for so-called obstructive hydrocephalus. Third ventriculostomy is one of the most classical treatments for hydrocephalic patients.²⁰,²² Dandy reported the first third ventriculostomy using a subfrontal approach in 1922.¹³ Amazingly, Mixter performed the first endoscopic third ventriculostomy the following year, using a urethroscope to successfully treat a pediatric hydrocephalic patient. Given the bulky equipment used in endoscopy, several attempts for modified third ventriculostomy were developed. Hoffman et al. reported stereotaxic third ventriculostomy with intraoperative ventriculography using a special apparatus.³⁰

Kelly et al. performed CT-guided stereotaxic third ventriculostomy with a ventriculoscope canule.³⁵ All cases recovered without shunting. With the development of a neuroendoscopy apparatus, larger numbers of series were reported in the 1990s.³³,³⁸,⁶⁰

Herein we review the pathological indications and age
limitations for endoscopic third ventriculostomy (ETV), along with complications encountered to date.

**What types of hydrocephalus should be indicated?**

Posterior fossa tumor should have one of the best indications for ETV. Fritsch et al. reported that in 23 pediatric patients with hydrocephalus due to posterior fossa tumors, only six patients (11.5%) required permanent treatment for hydrocephalus (VP shunt, n = 4; EVD, n = 2)\(^3\). No pathological differences in outcome were identified\(^2\). Al-Tamimi et al. reported on 12 patients under 18 years old who had presented with pineal region tumor and undergone ETV and tumor biopsies\(^2\). Eight cases underwent endoscopic biopsy during ETV. Diagnostic sensitivity for endoscopic biopsy is 75%\(^2\).

In another article on pediatric hydrocephalus with posterior fossa tumors, 107 patients were treated with early posterior fossa surgery (Group 1)\(^4\). In that group, 93 patients underwent total or subtotal tumor resection associated with external ventricular drainage (Group 1A), and 14 underwent stereotactic biopsy associated with ETV (Group 1B)\(^4\). The 53 remaining patients underwent elective posterior fossa surgery (Group 2)\(^4\). Early tumor resection (Group 1A) successfully resolved hydrocephalus in 85 patients (91%), whereas ETV resolved intracranial hypertension in 11 patients (12% of Group 1B)\(^4\).

In Group 1, persistent hydrocephalus affected 10% of the 107 patients, seven of whom had symptoms and were treated (shunts, n = 3; ETVs, n = 4). Persistent hydrocephalus was more frequent in children with severe preoperative hydrocephalus and with medulloblastomas\(^4\). Sainte-Rose reviewed cases of posterior fossa tumors and hydrocephalus divided into three groups: Group A, 67 patients with hydrocephalus present on admission in whom endoscopic third ventriculostomy was performed prior to tumor removal and midline tumor occupied 67 cases (100%); Group B, 82 patients with hydrocephalus who did not undergo preliminary third ventriculostomy but instead received conventional treatment and midline tumor presented on 56 cases (68%); and Group C, 47 patients in whom no ventricular dilation was present on admission and midline tumor appeared in 21 cases (45%)\(^5\). There were no significant differences between patients in Group A or B with respect to the following variables: age at presentation, evidence of metastatic disease, extent of tumor resection, or follow-up duration. In patients in Group A, however, more severe hydrocephalus was demonstrated; the patients in Group C were in this respect different from those in the other two groups\(^5\). These results mean that ETV was more frequently required prior to tumorectomy with midline tumors\(^5\).

Obstructive hydrocephalus shows various causes. Baldauf et al. reported on ETV for occlusive hydrocephalus caused by massive cerebellar infarction\(^6\). Ten patients with a mean age of 61.8 years underwent emergency ETV for cerebellar infarction\(^6\). Two cases required additional ETV and one case required suboccipital decompression\(^6\). Nine of 10 patients showed better GCS after the operation\(^6\).

Takahashi reported on the use of ETV in patients under 9 months old with obstructive hydrocephalus, classified into three groups based on MRI findings. Group I comprised six patients in whom the frontal horns of the lateral ventricles were enlarged and the cerebral cortical morphology was normal. Group II was made up of 13 patients in whom the entire lateral ventricle was enlarged bilaterally and the cerebral cortical morphology was relatively normal. Group III was composed of six patients in whom the lateral ventricle was markedly enlarged bilaterally and periventricular leakage of cerebrospinal fluid was evident\(^7\). Grade I patients showed virtually normal development as of 4 years old\(^7\). In Group II, development was still delayed in six patients at 1 year after ETV, and two of these patients underwent shunting. However, all patients in this group showed near-normal development at 5-6 years old\(^7\). In Group III, all patients underwent shunting within 1 year after ETV because no appreciable improvement of development was apparent at 6 months after the initial procedure\(^7\).

Non-communicating hydrocephalus must be a good indication for ETV. A retrospective review from seven international medical centers reported endoscopic third ventriculostomy for pediatric hydrocephalic patients\(^8\). No particular discrepancies were seen in the success rates of each institute. Success rates for treating subarachnoid hemorrhage or intraventricular hemorrhage (IVH), cerebrospinal fluid (CSF) infection or a combination of both pathologies were 60.9%, 64.3%, and 23.1%, respectively\(^8\). The success rate for the whole group was 60.9%. Among patients ≤15 years old, the success rate was 49.3%, whereas the success rate for adult patients was 78.6%\(^8\). A total of 22 technically successful ETV procedures were performed. The ETV success rate for controlling hydrocephalus was 81% and the rate of severe complications was 9%\(^8\). O’Brien et al. reported on 170 patients who underwent primary ETV and 63 patients who underwent ETV for VP shunt malfunction, with ETV success rates were 74% and 70%, respectively\(^8\). In the primary ETV group, patients with a history of IVH and meningitis as a cause for hydrocephalus showed poor success rates of 27% and 0%, respectively\(^8\). O’Brien et al. also reported on the application of ETV and endoscopic tumor biopsy (ETB) in 41 cases with...
pediatric midline tumor (pineal, \( n = 24 \); tectal plate, \( n = 9 \); midbrain, \( n = 3 \); thalamus, \( n = 3 \))\(^{47} \). ETV success rates of these patients were 68\% and no correlation was seen between ETV success rates and prognosis\(^{47} \). Histological examination of biopsy specimens was nondiagnostic in eight cases in which ETB was performed\(^{47} \). Seven of these cases involved pineal region tumors and one involved a tectal plate tumor, and stereotaxic biopsy was added in four cases and craniotomy in one case for diagnosis\(^{47} \).

Another article described ETV and ETB in 20 cases with pineal tumor, with pathological confirmation of diagnosis in 15 cases, but lack of verification for the remaining five patients\(^{51} \).

Fourth ventricular outlet obstruction (FVOO) is an uncommon cause of obstructive hydrocephalus, most commonly associated with prior IVH or intraventricular infection in children. Mohanty et al. reported 22 FVOO patients, with ETV performed for 10 <2 years old, six between 2 and 18 years old, and six >18 years old\(^{42} \).

They classified four groups based on operative findings at basal cisterns: Grade I (clear subarachnoid space, few or no strands) in six patients; Grade II (clear subarachnoid space, few strands) in eight patients; Grade III (mildly hazy space, moderate strands, basilar artery and neural structures still discernible) in three patients; and Grade IV (dense arachnoid strands, no discernible delineation) in three patients\(^{42} \). ETV failed in all infants <6 months old, whereas the success rate was 93\% in patients >2 years old (\( P = 0.0074 \)). A striking correlation was noted between outcome and status of the basal cisterns, with failed procedures in five of six Grade III or IV patients\(^{42} \).

In terms of correlating the status of basal cisterns with age, although older children and adults showed relatively clear basal cisterns, whereas arachnoid scarring was more predominant in infants and children <2 years old, the difference did not reach statistical significance\(^{42} \). Thickness of the third ventricular floor observed at surgery and correlations to overall outcome were also not statistically significant, although the procedure failed in five of the nine patients with a non-translucent floor.

Decq et al. reported that five young adults with hydrocephalus and showing Chiari type I malformation were treated by endoscopic third ventriculostomy without posterior fossa decompression\(^{14} \). Good results were seen in four cases.

Oi et al. reported various types of non-communicating ventricular dilatations, particularly long-standing overt ventriculomegaly in adulthood (LOVA)\(^{49, 50, 52} \). In an early report for seven LOVA patients who underwent ETV and aqueductoplasty, 57\% of patients showed excellent results\(^{19} \). Two patients with LOVA needed VP shunt because it was thought that the endoscopically opened route had been obliterated by the clot or CSF circulation was still poor in the subarachnoid space\(^{49} \).

ETV failure may be abrupt in onset, causing a potentially life-threatening increase in intracranial pressure (ICP)\(^{4} \). Aquilina et al. reported the usefulness of a ventricular reservoir as follows: diagnosis of recurrent hydrocephalus by pressure assessment in 19 cases; diagnostic cerebrospinal fluid aspiration in five cases; postoperative external ventricular drainage in four cases; emergency ventricular access for acute recurrence of hydrocephalus in two cases; and diagnosis and management of ventriculitis in two cases (as complications of reservoir operation)\(^{4} \).

In cases with ventricular dilatations and adjacent cystic components, neuroendoscopic transventricular ventriculocystostomy was applicable\(^{16} \). Size reduction was achieved for 10 adjacent cysts\(^{16} \).

Idiopathic normal pressure hydrocephalus (iNPH) can be difficult to diagnose accurately, and CSF shunt remains the first-choice surgical treatment\(^{9} \). Improvement rates in several recent studies were in 65–80\%\(^{36} \). Gangemi et al. reported that 25 ETVs were performed for patients with iNPH\(^{25} \). Overall rate of neurological improvement after ETV in our series was 72\%\(^{25} \). Improvement of gait disturbance was significantly higher (73\%) as compared with that of dementia (16\%) or urinary incontinence (31\%)\(^{25} \). Gangemi et al. also reported in an ETV multicenter study for iNPH that the rate of neurological improvement was higher in patients with shorter clinical history, better preoperative neurological score, and clinical onset with gait disturbances\(^{26} \). Intraoperative findings of the sudden reappearance of normal cerebral pulsations and significant downward and upward movements of the third ventricular floor after ETV were also correlated with good outcomes for iNPH\(^{26} \).

**How young can ETV become applicable?**

In recent articles, ETV success rate in adults was 83\%, including for tumor, long-standing overt ventriculomegaly, Chiari malformation Types I, II, aqueduct stenosis and IVH\(^{52} \). In the secondary group (shunt malfunction), ETV was successful in 67\%\(^{32} \).

According to a study of ETV in children <6 months old, ETV was successful in 57\% of patients who experienced regression of signs of intracranial hypertension\(^{40} \).

Balthasar et al. reported that optimal timing should be ≥4 months after birth for ETV from the analysis of 12 cases\(^{7} \).

Gorayeb et al. reported that in patients <1 year old (mean, 4.7 months), the success rate was 64\% and complications mainly involved meningitis\(^{27} \).
Patients with Chiari II malformation and aqueductal stenosis showed lower success rates (45%, 55%) compared with other forms of obstructive hydrocephalus (86%)\textsuperscript{27}. Even infantile ETV patients showed varying success rate between the 1st semester (52%) and 2nd semester (85%)\textsuperscript{27}.

A series of ETV in patients <2 years old reported that failed procedures were more frequent in patients <6 months old, and idiopathic aqueductal stenosis with associated hydrocephalus showed a good outcome in 50% of the patients\textsuperscript{6}. Patients older than 1.5 years showed a good success rate\textsuperscript{6}. From an article on ETV performed at <1 year old, median age was 206 days (range, 82–311 days) in successful cases and 94 days (range, 8–299 days) in unsuccessful cases\textsuperscript{37}. Navarro et al. identified several significant factors influencing the late ETV failure rate: age <12 months; hydrocephalus without expansive lesions; placement of an external ventricular drain (EVD) after ETV; and development of early complications\textsuperscript{46}. In a series of 18 infantile ETV cases, Infants with obstructive hydrocephalus had a 100% success rate (four of four), and infants with communicating hydrocephalus had a 10% success rate (one of 10). In infants with hydrocephalus related to myelomeningocele, the success rate was 50% (two of four)\textsuperscript{24}. Because of the poor results of ETVs in such cases, they recommend VP shunt for infants with communicating hydrocephalus secondary to IVH or meningitis\textsuperscript{24}. Drake et al. reported that one-year complication–free survival after ETV were less than CSF shunt in infant and neonatal periods\textsuperscript{19}. Age is a major determinant of outcome from CSF diversion, with worse outcomes in young patients\textsuperscript{19}.

Kadrian et al. reported a retrospective analysis of 181 ETV cases from a single institution and analyzed the long-term reliability of ETV\textsuperscript{34}. The statistical model predicted the following reliability at 1 year after insertion: at 0–1 month old, 31%; at 1–6 months old, 50%; at 6–24 months old, 71%; and at >24 months old, 84%\textsuperscript{34}. Drake et al. combined patients from nine pediatric neurosurgery centers across Canada to obtain a better estimate of outcomes and identify factors affecting the success of ETV\textsuperscript{18}. In the 368 patients, mean age was 6.5 years, and aqueduct stenosis and tumors were the most common etiology\textsuperscript{18}. The 1- and 5-year success rates were 65% and 52%, respectively\textsuperscript{18}. The 5-year success rate in patients <1 month old was 28%, compared with 68% in patients >10 years old\textsuperscript{18}. Multivariate analysis only showed age as having a significant effect on outcome, with younger patients showing higher failure rates, particularly in neonates and infants\textsuperscript{18}.

In a series of 275 ETVs, 66 procedures were performed in children <2 years old\textsuperscript{8}. The overall success rate of ETVs in patients <2 years old in our cohort of patients was 53%\textsuperscript{8}. However, success rates differed markedly between different etiologies of hydrocephalus, varying between 27% in patients with hydrocephalus in association with meningomyelocoele with no previous shunting and 87% in patients with aqueductal stenosis\textsuperscript{8}. The success rate in every age group mainly depended on the etiology of hydrocephalus, not on the age of the patient\textsuperscript{8}.

A similar conclusion has been reported, that selective use of ETV as the primary treatment for hydrocephalic infants is safe and can lead to an up to 21% reduction in the shunted population of all newly diagnosed patients, and that success of ETV is dependent on etiology, not age\textsuperscript{31}.

### How to prevent complications?

**Late rapid deterioration after ETV is a rare complication, but is often fatal\textsuperscript{17}**. Seven reports and nine international e-mail interviews have described 16 pediatric cases showing late rapid deterioration after ETV, with fatal outcomes in 13 cases and ETV occlusions in almost all cases\textsuperscript{17}. This phenomenon occurred 1.4–84 months after ETV (mean, 2.5 years)\textsuperscript{17}. The fatal complication occurs seems to be around 1 in 200–250 ETVs. Tuli et al. reported that in pediatric CSF shunt mortality rate was 10 deaths per 907 cases, the patients with neoplasms were excluded because their deaths were predominantly related to the tumor\textsuperscript{59}.

Whether to use ETV or CSF shunt as the surgical procedure in patients with hydrocephalus remains controversial\textsuperscript{10, 15, 36, 57}. Bilginer et al. reported that ETV for VP shunt malfunction patients, overall success rate for ETV after shunt malfunction was 80% (36 patients) and failure rate was 20% (9 patients)\textsuperscript{10}.

Injury to the basilar artery or related branches is a rare but severe complication of ETV\textsuperscript{15, 54}. Incidence is nearly 1%, practically equivalent to that of the mortality linked to the surgical procedure\textsuperscript{15}.

According to Schroeder et al., 22 of 193 patients with ETV experienced complications, comprising 15 adults and seven pediatric patients\textsuperscript{54}. Almost all recovered well, but two patients died (severe meningitis, \(n = 1\); subarachnoid hemorrhage with torn basilar perforators, \(n = 1\)\textsuperscript{54}). They reported complications were more common in the 1990s and became more rare in the 2000s\textsuperscript{54}.

CSF leakage is sometimes an intractable complication after ETV. Costa Val reported that in babies within the first 24 months of life with an open anterior fontanel, a curved scalp incision was made over the anterior fontanel\textsuperscript{12}. The fontanel and lateral edge of the frontal bone were exposed and osteoplastic minicraniotomy
was performed. No cases with CSF leakage and/or complications were encountered.

Kombogiorgas and Sgouros measured sizes of 32 ETV stomas as the distance from the basilar artery to the posterior clinoid process, finding a mean stoma size of 37%–38. In patients without previous shunt (n = 17), stoma size >30% associated with ETV success (p = 0.088) 38. CSF leak was adversely associated with ETV success and mean stoma size was 41.3% for successful ETV and 27.8% for unsuccessful ETV 38. In patients without previous shunt, stoma size may correlate with success and CSF leak appears strongly associated with failure 38. In a study of 155 patients and 173 ETVs, overall complication rate per procedure was 18%–21. Cases were divided into three categories showing: intraoperative complications; early postoperative complications (≤1 month); and late complications (>1 month) 21. Early postoperative CSF leakage was the most common complication, followed by late postoperative restenosis of stoma 21. Complication rate varied significantly with the etiology of hydrocephalus, with patients showing Chiari type I malformation and tumor displaying no or very low complication rates 21. The risk of complications was significantly higher for repeat endoscopic procedures (55.5%) than for the first procedure (10%; P = 0.0001) 21.

Cinalli et al. reported on alterations in ICP after ETV in non-communicating hydrocephalus in pediatric patients 11. ICP was continuously recorded for an average of 7 days in 64 children who underwent 68 ETVs for obstructive triventricular hydrocephalus of various etiologies 11. After 31 procedures (45.6%), ICP remained normal (<20 mmHg) for the entire duration of monitoring 11. After 37 procedures (54.5%), ICP was persistently high on Day 1 (mean, 29.7 mmHg) and decreased very slowly in subsequent days, remaining high for 2–9 days (mean, 4.5 days) 11. In 13 patients (19.1%), ETV failed and a ventriculoperitoneal shunt was implanted. After four procedures, the stoma became obstructed and the patients were treated to reopen the stoma 11. Postoperative ICP was not significantly higher in patients in whom ETV failed 11.

Post-ETV infection is one of the most awful complications, occurring in 8.08% / ETV 41. This complication usually occurs within the first 2 weeks after ETV 41. In an article on ETV with previous shunt operation, a total of 131 patients were identified as comprising 86 patients who underwent ETV as a primary procedure and 45 patients who received ETV at the time of shunt malfunction 28. Serious complications after ETV occurred more frequently in patients who presented with shunt malfunction (14 of 45 patients, 31%) compared with patients who underwent primary ETV (7 of 86 patients, 8%) 28. Previously shunted patients with a history of two or more revisions and who experienced serious complications at the time of ETV were more likely to require shunt replacement 28.

In a case of complex shaped hydrocephalus, identifying anatomical structures is sometimes difficult. Hayashi et al. reported a transparent sheath composed of a thin polypropylene outer tube and an obturator 29. The sheath measures 10 cm in length, 5.2 mm in outer diameter, and 4.7 mm in inner diameter 29. It provides excellent visibility without troublesome bleeding from tissues surrounding the foramen of Monro during rigid endoscopic procedures 29.

In response to ETV, ventricular volume falls to a value lower than preoperatively, but higher than the normalized value for age and sex 36. All patients appeared to have supranormal volumes in the long term, with volume stabilizing at 3–6 months 36.

Constructive interference in steady-state, 3-dimensional, Fourier transformation (CISS) magnetic resonance imaging in the endoscopic management for 11 of 15 procedures provided better brain tissue/cerebrospinal fluid contrast, allowing better understanding of the cause of hydrocephalus and the nature of the cysts 3. CISS is useful to determine the results for ETV 3. ETV malfunction can be diagnosed by detecting flow void from the stoma on MRI with T2 sagittal fast spin echo (FSE) 44.

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References

6. Baldauf J, Oertel J, Gaab MR, Schroeder HW:
40. Lipina R, Regulí Š, Doležilová V, Kunčíková M, Podešová H: Endoscopic third ventriculostomy for...
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From Basic to Most Advanced Neuroendoscopic Technique with “Oi Handy Pro™”

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Summary

Concept of “Oi Handy Pro™” Neuroendoscope
The “Oi HandyPro™” endoscope is the result of several years of neuroendoscopy invention. The author’s experience, as well as that of other colleagues, has formed the basis for the design of a new device with potential for improving certain features of the endoscope used in the neurosurgical field. It is a handy rigid-shaft neuroendoscope that combines several major advantages; high-resolution imaging with right illumination, mobile manipulation with “frameless free-hand maneuvering,” and a lightweight body with fine surgical instruments. This new instrument is presented and its unique features as they relate to neurosurgery are described.

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Indication for Neuroendoscopic Surgery

Part 1: Arachnoid Cyst
Case No.1  A 7-year- old-male with Left Middle Fossa Arachnoid Cyst

History:
The patient underwent CT study with an episode of minor head injury. The CT demonstrated a giant size of arachnoid cyst in left middle fossa extending to left cerebral convexity. He is right-handed but has no specific symptom.

Neurological Examination:
The neurological examination revealed no neurological deficit. His intelligence quotient (IQ) was 147 [performance 157, verbal 137].

Neuroimaging: (CT scan)


QUESTION

No.1 What is your opinion?
No.2 How would you approach, if indicated for surgery?
“My Opinion”

[ ] Fax: 0081-3-3235-9377 [ ] e-mail: shizambroi@aol.com

NEUROENDOSCOPY On-line Journal Consensus Conference [NEOLJCC]
on NEOLJCC No.__________

[ ] I agree! [ ] I disagree!

How would you approach, if indicated for surgery?
[ ] Open Surgery [ ] Neuroendoscopic Approach

Comment

Name: ____________________________________________, M.D.
Institute: ____________________________________________ City: ___________,
Country ___________
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institute/country in “Journal of Neuroendoscopy”.
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